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ABSTRACT

This paper, fifth in a series produced by the Science and Mathematics Education Information Analysis Center, is based on an address given at the 44th Annual Meeting of the National Association for Research in Science Teaching by an Assistant Superintendent of the Cleveland Public Schools. Curriculum developers have tended to view curriculum as segments of subject matter, ignoring "how, for what purpose, to whom and by whom it is to be learned and taught." Criteria for judging curricula in terms of authenticity, inclusiveness, and teachability are discussed, and a need for evolving, not static, curriculum models indicated. The role of the school, of teachers, of university education and subject-matter scholars, technicians and evaluators in designing and implementing curricular change is considered, and the necessity of partnership emphasized. (AL)

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SCIENCE EDUCATION INFORMATION
REPORTS

OCCASIONAL PAPER SERIES - SCIENCE
PAPER 5 - MODELS AND RESEARCH IN
SCIENCE EDUCATION CURRICULUM DEVELOPMENT

by

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TABLE OF CONTENTS

Introduction ..... 1

Criteria for Judging Curriculum ..... 4

Authenticity ..... 4

Inclusiveness ..... 5

Teachability ..... 6

Curriculum Change Models ..... 7

Who Ought To Do What? ..... 8

Credulity: Shall We Overcome? ..... 9

Role of the School ..... 9

References ..... 12

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Robert W. Howe
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Editors

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## INTRODUCTION

The past fifteen years have represented a period of probably unprecedented activity in what has often been referred to as curriculum reform. Much of the flurry of activity has been of the "rediscover fire" variety. Some, however, hold promise of significantly advancing this nation toward the proper goal of a dynamic educational climate with expanding inclusiveness in the benefits of educational opportunity.

Professor Thesher, a few years ago, assessed accurately the climate of American opinion which nourishes the interest in educational improvement and reform. He called attention to six aspects of that climate:

1. An advance in public appreciation of the key importance of education

2. The discovery that the reservoir of potential undeveloped talent is more vast than previously suspected

3. The emergence of ideas about salvaging human ability

4. Changes in ideas about who should benefit from education and of how to achieve this

5. The discovery (or rediscovery) of the importance of children's intellectual appetite and their joy in learning

6. A regeneration of the idea that "education is a seamless web" and that the stages into which we have decided it are the result of historical accident or administrative convenience (8).

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This paper is based on an invited address delivered at the 44th Annual Meeting of the National Association for Research in Science Teaching (NARST), Sheraton Hotel, Silver Spring, Maryland, March, 1971.

There are, of course, other suggestions that the apparently renewed concern for education grows out of interests which, but coincidentally, involve the general and personal welfare commitment of the United States. Whatever the motivation, it cannot be denied that there is great interest and activity in the matter of curriculum development. No area of the national educational enterprise has received more attention than the reconstruction or reordering or invention, if you prefer, in science education.

Supported by great sums of federal money and other funds, practically every branch of science has been undergoing examination, redefining of content priorities, the development of new and/or different content, and the production of impressive looking packages each bearing proudly its own symbolic standard. As a matter of fact, science education literacy is probably gauged consciously or otherwise by the frequency, if not accuracy, with which one uses terms like SCIS, ISCS, ESCP, BSCS, SMSG, IPS, CBA, PPC, PSSC, ACSP, ECCP, and Minnemast. In a recent (1970) publication of the National Science Foundation I counted thirty-two such symbols, each representing a different project (15).

These laudable efforts to fill various obvious needs for improvement in school science programs have dealt principally with what their inventors, developers, and disseminators consider curriculum reform.

Curriculum has been defined as broadly as all the experiences of the learner's life. It has also been defined as narrowly as the published course of study for a semester's or year's work in a given subject, or even as the subject matter content of such a course. The recent efforts in science education seem to reflect the view that curriculum consists of some segment of the subject matter, preferably in some purified state, of the respective discipline. The appropriateness of the particular segment appears to have been determined by scholars based in a few selected universities upon whom there seems to have been conferred a status approaching infallibility.

As Woodring points out, these current curriculum revisions represent "a return to the older tradition that dominated the secondary schools before the progressive revolution" with university scholars and scientists playing the major role in determining what is to be taught, to whom, and in what way (11).

A definition of curriculum appropriate to the educational tasks of today must have greater breadth than the course of study, but must be focused more precisely than the all-of-life coverage.

It must point with clarity to the student and his development and show the relationship which that development bears to the function of the school. The following definition, it is believed, has viability for today's schools:

> Curriculum consists of the continuum of potential experiences provided by the school to enable pupils to attain the learning objectives for which the school has either distinctive or shared responsibility (1).

The narrow view of curriculum characteristic of the recent science programs has led those in that revisory movement to restrict their efforts mostly to the simple preparation of different kinds of subject matter content, thus limiting greatly the potential impact of the change efforts upon school practices.

The point is that effective curriculum change must deal not only with what is taught but how, for what purpose, to whom, and by whom it is to be learned and taught (3). This process must include consideration of the best that is known about potential learners and learning, as well as the latest and most accurate information available concerning the circumstances under which the potential learners and their mentors are likely to, or reasonably can be expected, to function.

Another way to approach the issue of achieving and maintaining curricular relevance is to consider discipline as a concept having operational pertinence. Phenix a few years ago offered this definition: "knowledge organized for instruction." "The distinguishing mark of any discipline," he states, "is that the knowledge which comprises it is instructive -- that is, peculiarly suited for teaching and learning" (7).

The three fundamental features of a discipline which make such a body of knowledge instructive are viewed as: analytic simplification, synthetic coordination, and dynamism. A body of knowledge qualified as a discipline, then, if it simplifies understanding, reveals significant patterns and relationships, and generates further analysis and synthesis. "Disciplined ideas," says Phenix, "not only constitute families of concepts, but these families beget progeny." Phenix holds hat what is taught (content) should be drawn from the disciplines (7). While his suggestion that the disciplines constitute the only appropriate source of curriculum content may not be wholly acceptable, we do suggest that school experiences should be selected and designed to enable the learner not

only to acquire information but to learn to use it as the basis for new information. As Dale points out we should emphasize "creative explication, implication, and application" (2).

## CRITERIA FOR JUDGING CURRICULUM

It seems to me that any proposed curriculum modification must be tested against three important criteria, among others: authenticity, inclusiveness, and teachability.

Authenticity refers to the degree to which the proposed set of concepts, skills, content, materials and methodologies meet generally accepted standards of scholarship within the affected discipline. For example, if we are dealing with physics, the material to be included should be those which would be acceptable by consensus among competent physicists on the basis of accuracy and legitimacy.

Inclusiveness has to do with completeness. In the application of this criterion, the aim is to make the subject matter coverage of the curriculum as comprehensive as possible.

Inclusiveness has another aspect. An area of the curriculum which meets this criterion is characterized by a wide range of appropriate learning opportunities. In other words, in the development of the inclusive curriculum in any field it should be recognized that different individuals may learn a concept or fact in different ways without violating the integrity of the concept or fact.

The third criterion, teachability, has to do with the usability of the recommended materials and processes by those who must mediate between the learners and what is to be learned -- the teachers -- those now so employed and those likely soon to be employed.

Let us turn then to a consideration of the efforts in science curriculum development related to these three criteria.

### Authenticity

With respect to authenticity, I leave the question to those competent within their respective disciplines. The physicists are best prepared to determine whether and which of the new physics

approaches are legitimate. Likewise in mathematics or biology or anthropology or chemistry, and so forth.

I assume there is more consensus than dissent among scholars representing a particular discipline.

## Inclusiveness

The first aspect of inclusiveness, that is, completeness, is also probably the province of scholars within the discipline involved. It was ostensibly concern for the lack of completeness and authenticity that led to the current activity in science curriculum in the first place.

On the issue of inclusiveness as it is related to range of potential learner involvement, though, the situation is different. There has been minimal effort in the science curriculum revisions to expand their potential for including more children and youth in the study and appreciation of the scientific. They are geared mainly to providing usually more intricate scientific learnings for students who will enter a traditional collegiate academic program. Little attention is directed to the need for increased scientific intelligence among the general population.

Moreover, little attention is given to the fact that scientific concepts and skills can probably be handled adequately and in depth by a wider range of the population than heretofore thought capable. All ideas about who has or has not the ability to study what must be regarded as tentative.

In this society, arbitrary selection procedures which preclude from certain actions and benefits large segments of the nation's people are inconsistent with the national interest, as well as morally questionable.

Schools today enroll more of the age-eligible population than ever and students remain in school longer. This situation presents both a challenge and an opportunity. The education establishment has the obligation to serve thousands who a generation or two ago would not have been in school. The old role of the school as a screening device is inappropriate to today's needs.

The task of the curriculum developer in this day is not the restriction of participation in the affairs of his discipline but the expansion of that participation. The role of education and schooling in this last third of the century is to open new options for more and more of America's youth.

Teachability

Turning next to teachability as a concern of the new curriculum efforts, we find that only slight attention has been directed to this dimension of curriculum reconstruction in the sciences. This lack of attention to teachability contributes to the limited inclusiveness of the new curricula.

The teachability factor seems to have been handled about like this: The revised content is determined by a select committee sometimes including a few secondary school teachers regarded as outstanding by the university scholars in the particular discipline. What this special group develops is then disseminated to a limited number of other teachers who are instructed in the new ways to proceed. Usually this group of trainees has been limited to those regarded by their supervisors as outstanding. Then another generation of similar people has been chosen and instructed, frequently if not generally, from schools different from those of the previous trainees.

This procedure seems to be based on some idea, clearly untenable, of the ability of one or two exceptional teachers in a school or a school system to influence their colleagues by the force of their presumed status leadership. I suppose that we expect that though some sort of osmotic process this will occur. One now sees some hopeful references to the need for training at the pre-service level as a priority ahead of in-service work involving present teachers.

Both thrusts are necessary. However, an important point is too frequently overlooked. What we need is not only the effort to train and retrain teachers in the substance of the new curriculum approaches but also, and more importantly, to seek and identify the different ways in which the revised curriculum substance can be put into forms that can be transmitted through logical, effective teaching behaviors, of which far larger numbers of teachers are capable than we have assumed up to now.

As a matter of fact, the teachers included in the original committees ought to include more than the exceptional. There ought to be some who are far more representative of the general teacher population. This would save much time and effort as the second generation translations would be unnecessary. Moreover, the training needs of teachers generally, both in substantive and in pedagogical areas could be more readily and accurately identified by the curriculum design team.

What is needed is to help teachers acquire skill in simplifying ideas and concepts for themselves first, and as a basis for transmitting that skill to students. Teachers for the real world also need skill in helping pupils discover relationships among ideas as well as skill in constructing and arranging the learning-teaching environment in such a way that further inquiry is not only made possible but encouraged.

I note that there is now some emphasis on the training of supervisors and other similarly situated personnel in school systems (6). This effort recognizes the importance of multiplier potential and address itself to the proper target group. Such a step will continue to generate benefits as supervisors who are responsible for the professional growth of teachers in service will be better equipped for this important part of their role.

In addition, the wider involvement of supervisory personnel will greatly improve the chances for acceptance of new and revised approaches by teachers. Supervisors are still generally regarded by teachers as the most accessible authorities in their respective disciplines or field of specialization.

## CURRICULUM CHANGE MODELS

Let us briefly look at some other important considerations related to curriculum development and change. Curriculum change is a human activity. It involves change in the way people think and behave. What has this to do with modeling? We get ourselves into difficulty when we attribute to a curriculum package qualities, which in the nature of human relations, it cannot have.

Too many curriculum models are based upon the assumption that school situations are, or can be, identical. The fact is that while there are certainly many similarities among school situations, identicalness is a quality that is probably unattainable among human endeavors. Hence, the principal source of difficulty in our usual idea of modeling is that we see a particular package or design as archetypical rather than only prototypical. Too often pride of authorship gets in the way of genuine scholarship.

The proper use of models in curriculum development is to provide guidelines based upon accurately and adequately described experience. Frequently commercial considerations, or considerations of some other kind, interfere with the accuracy and/or the completeness of descriptions of the modeler's experiences.

I suggest that a definition of model which would be acceptable in curriculum development would be something like this one from the American Heritage Dictionary: "a tentative ideational structure used as a testing device."

Models which evolve in curriculum development in any field of study ought to do just that -- evolve. Modeling in curriculum development ought to be considered process-like rather than productional.

## WHO OUGHT TO DO WHAT?

The matter of role appropriateness in curriculum projects needs much more than the passing attention it now receives. This is required in the interest of economy of effort as well as in producing the most useful curriculum products and processes.

What must surely be avoided are jurisdictional squabbles between those who proudly think of themselves as discipline-oriented and those whose main interest is pedagogics. There need be no tug-of-war over who should initiate curriculum reform or who should control the process. What we must work out is a parity relationship which provides for input and impact at appropriate points by those with a legitimate stake in the outcome. The scholars in the respective subject matter disciplines validate content. The scholars in pedagogy determine teaching procedures. Classroom teachers, who may also be scholars in either subject matter or pedagogy, develop usable teaching units. Parent and student reaction is a barometer of relevance. Technicians design packages and media. Evaluators determine effectiveness of the various phases of the process, the process as a whole and the products generated.

All of these parties play significant roles in curriculum development. Each must function properly and in partnership with the others or none will be successful in improving student learning.

Specifically rejected here are the notions of hierarchy usually associated with professional education activities. When the senior professor in the major university can be accurately perceived both by himself and by classroom teachers as a member of a partnership, we shall be on the way to role appropriateness in curriculum work. And when they can both listen to, solicit, and accept suggestions from students and their parents without being threatened or feeling demeaned, American education will move significantly toward fulfilling its promise.

Van Til in referring to this necessary partnership says,

> The challenge of the 1970's in regard to curriculum change is to establish a process in which multiple forces will be taken into account, yet reasonable decisions can be made. We cannot afford a paralysis created by endless discussion. Nor can we allow confrontation to prevail as the accepted way of making curriculum change. We have to develop new ground rules for a wider sharing in curriculum decision making which utilizes more effective democratic processes than have even been devised (19).

## CREDULITY: SHALL WE OVERCOME?

There will probably not be really significant progress in curriculum change until we in the field become more discerning consumers of the scholarship in our disciplines.

There currently exists an almost incredible credulity which sees us taking as firm law the most tentative hypothesis propounded by some one of academic stature (and not infrequently by someone whose stature is established principally by a facile pen).

This situation must be embarassing to many legitimate scholars who find it necessary to explain their positions repeatedly. What we need is a kind of academic consumerism. Organizations such as this have an especially important role to play in establishing and maintaining that consumerism.

## ROLE OF SCHOOL

How one views curriculum development will depend largely upon what one regards as the role of schooling. For most of its history the American school has been seen as an agency whose main function was to equip the young with some limited literacy and computational skills. Only a few were expected to complete the requirements for high school graduation. The scholastically more apt, identified usually by their skills in verbal activities, were selected in the filtering process and the traditional school program designed and executed particularly in their behalf. Rapidly changing economic and social conditions as well as an awakening concern for the welfare of children and youth have led the school to a more consistent with democratic values.

This concern for humaneness was, unfortunately, upstaged and almost submerged during the past decade and a half as we concentrated increasingly on the race to beat the Russians and others to the moon. We came, and stand now, perilously close to redirecting the schools of the nation to the old screening task, to measuring educational effectiveness in terms of scores on achievement tests and college admissions rather than in terms of the relevance of students' learning for helping people live together harmoniously.

The school today must accept responsibility for leadership in widening the channels of the American lifestream so that all segments (I reject the term strata) of the American people will find themselves genuinely and comfortably included. Our survival as a nation depends upon the rapidity with which we can divest ourselves of the notion that there are, or ought to be, major, minor, or silent partners in the enterprise that is America.

The decade of the seventies provides another opportunity for renewing and intensifying the search for more and better ways to have learners not only acquire knowledge but discover its evolving meaning for improving life for us all. The overriding purpose of education in the seventies is to make the human condition humane. The school as the chief non-family agency involved in education has a major role to play in meeting the challenge (1). Humaneness in the quality of schooling will depend not only on what is taught, but how it is taught and how the school is organized and administered.

In the humane school it is a proper function to guide students in acquiring the increasingly acute discernment necessary to recognize problems, both personal and social. Their cognitive growth will be facilitated as learning opportunities are arranged in such a way that their operational knowledge base is broadened and deepened so that they can deal with problems rationally. Their self esteem will be fostered and reinforced through successes in learning so that they will have the confidence to attack problems -- personal and social.

Wilhelms has identified two facets of the role of the school in his discussion of currently pressing demands upon education and schools:

1. Maximum effective help to each young person in his learning

2. Programs designed to go straight to the great social agenda of the here and now.

Illustrative of items on the great social agenda are pollution, depletion of key resources, problems of race and intergroup hostilities, the neglect of cities, war, and poverty (10).

Gardner emphasizes the need for priority consideration of humane values as he suggests that as a people, Americans are forgetting that we are interdependent. He warns, "If Americans continue on their present path, their epitaph might well be that they were a potentially great people ... a marvelously dynamic people ... who forgot their obligations to one another, who forgot how much they owed one another" (4).

Today represents a challenge of particular concern to the science educator. If science educators fail to invest sufficient time, effort, and intelligence in the great social agenda of this day, they shall certainly forfeit their claim to recognition as educators or scientists.

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